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FOR

A METHOD AND SYSTEM FOR ENHANCING CRANKBACK HANDLING
IN MULTI-PEER GROUP NETWORKS

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A METHOD AND SYSTEM FOR ENHANCING CRANKBACK HANDLING IN MULTI-PEER GROUP NETWORKS

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TECHNICAL FIELD

This invention relates to the field of computer system networking. More particularly, the present invention relates to an improved network system to

15   handle connection failures.

BACKGROUND ART

The widespread deployment of large, interconnected computer system networks has transformed the nature of communication. The largest such

20   network, the Internet, is a general purpose, public computer network which allows millions of computers all over the world, connected to the Internet, to communicate and exchange digital data with other computers also coupled to the Internet.

25   ATM (Asynchronous Transfer Mode) is a network technology for both local and wide area networks (LANs and WANs) and the Internet that supports realtime voice and video as well as data. ATM technology is often deployed on such networks because of its ability to provide consistent network connections. The ATM topology uses switches that establish a logical circuit

30   from end to end, which guarantees quality of service (QoS). However, unlike telephone switches that dedicate circuits end to end, unused bandwidth in

5   ATM's logical circuits can be appropriated when needed. For example, idle

bandwidth in a videoconference circuit can be used to transfer data. ATM is

widely used as a backbone technology in carrier networks and large

enterprises.

10   Consistent QoS is highly dependent on the efficiency of routing protocols

implemented by the networks. PNNI (Private Network-to-Network Interface)

is a routing protocol used between ATM switches in an ATM network. PNNI

lets the switches inform each other about network topology so they can make

appropriate forwarding decisions. A primary objective of PNNI is to enable

15   ATM switches to dynamically reroute packets based on current network line

conditions.

           The PNNI specification was developed by the ATM Forum to provide a

crankback mechanism to do alternate routing when the connection setup in

20   progress encounters a failure in the network. In such a case, when a

connection problem or failure is detected, the specification defines the manner

in which the switches reroute a connection to avoid the problem.

           However, there is a limitation in the ATM Forum PNNI specification

25   with respect to crankbacks. The problem is how the crankbacks are handled

by the entry border nodes in the multi-peer group networks. In multi-peer

group networks, the nodes in a peer group know only about the nodes within

the peer group and have only summarized information of nodes outside the

peer group. Due to this information being aggregated, the exact crankback

30   location cannot be specified outside the peer group.

5   If the entry border of a peer group cannot route a call to the destination and if the cause of call failure is within the peer group, then, according to the ATMF PNNI specification, the entry border node specifies that the crankback has occurred at the next higher level. This is because the entry border node cannot exactly specify to the source node which peer groupe node has the

10   failure.

        This higher level crankback is translated to a blocked node of the logical group node and so, the source node processing this crankback would treat the whole peer group as blocked. If this entry border node crankback happens on

15   the destination peer group, or if it happens on a transit peer group that is the only route to reach the destination node, then the calls and/or connections will never get routed. The failure to complete the call, even though sufficient ATM switch resources are available to do so, defeats the purpose of QoS configuration of the ATM switches. This problem has been widely observed in

20   many multi-peer group deployments. There is no solution available through PNNI or other standards.

        Thus, what is needed is a solution that can efficiently handle crankback rerouting in multi-peer group networks. The needed solution should be

25   compatible with existing network standards.

5   <u>DISCLOSURE OF THE INVENTION</u>

Embodiments of the present invention provide a method system for enhancing crankback handling in multi-peer group networks. Embodiments of the present invention efficiently handle crankback rerouting in multi-peer group networks. Embodiments of the present invention are compatible with

10   existing network standards.

In one embodiment, the present invention is implemented as a method for crankback handling in a multi-peer group network. The method includes receiving a first connection request from a node of a first peer group (e.g., a

15   preceding peer group). Upon detection of a call failure within a second peer group (e.g., a succeeding peer group), a crankback is transmitted from the second peer group to the first peer group. The crankback specifies a blocked interface at a first link between the first peer group and the second peer group. The crankback is transmitted from a node of the second peer group. A second

20   connection request is subsequently received from the node of the first peer group. The second connection request uses a second link to the second peer group that avoids the call failure. The blocked interface causes the originating node to use an alternate exit border node node within the first peer group to implement the second link to the second peer group.

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In one embodiment, the node of the second peer group (e.g., the succeeding peer group) is an entry border node configured to receive connection requests for the peer group. In one embodiment, the node is an ATM switch of an ATM network operating in accordance with a PNNI specification.

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5   BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and form a part of this specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention:

10   Figure 1 shows a diagram illustrating a first network configuration in accordance with one embodiment of the present invention.

Figure 2 shows a diagram illustrating a second network configuration in accordance with one embodiment of the present invention.

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Figure 3 shows a flowchart of the steps of an enhanced crankback process as practiced by a network in accordance with one embodiment of the present invention.

20   Figure 4 shows a general block diagram of an ATM switch in accordance with one embodiment of the present invention.

5 <u>DETAILED DESCRIPTION OF THE INVENTION</u>

Reference will now be made in detail to the embodiments of the invention, examples of which are illustrated in the accompanying drawings. While the invention will be described in conjunction with the preferred embodiments, it will be understood that they are not intended to limit the

10 invention to these embodiments. On the contrary, the invention is intended to cover alternatives, modifications and equivalents, which may be included within the spirit and scope of the invention as defined by the appended claims. Furthermore, in the following detailed description of the present invention, numerous specific details are set forth in order to provide a thorough

15 understanding of the present invention. However, it will be understood by one of ordinary skill in the art that the present invention may be practiced without these specific details. In other instances, well known methods, procedures, components, and circuits have not been described in detail as not to unnecessarily obscure aspects of the present invention.

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Embodiments of the present invention provide a method system for enhancing crankback handling in multi-peer group networks. Embodiments of the present invention efficiently handle crankback rerouting in multi-peer group networks. Embodiments of the present invention are compatible with

25 existing network standards. The present invention and its benefits are further described below.

Figure 1 shows a diagram illustrating a network 100 in accordance with one embodiment of the present invention. As depicted in Figure 1, the network

30 100 includes a plurality of nodes 11-25 coupled by network communication links as shown. Nodes 11-15 are included in a peer group 10 (e.g., a preceding

5   peer group). Nodes 21-25 are included in a peer group 20 (e.g., a succeeding

peer group).

The network 100 embodiment of the present invention functions by

implementing an enhanced crankback mechanism for handling connection

10   failures between the nodes of the peer groups 10 and 20. As depicted in Figure

1, each of the nodes 11-25 comprise one or more ATM switches. The network

100 is an ATM based network.

The ATM switches comprising the nodes 11-25 function as packet

15   switches, transmitting all traffic as fixed-length, 53-byte cells. As known by

those skilled in the art, this fixed unit allows very fast switches to be built,

because it is much faster to process a known packet size than to Figure out

the start and end of variable length packets. The small ATM packet also

ensures that voice and video can be inserted into the stream often enough for

20   realtime transmission.

The ATM switches comprising the nodes 11-25 are able to coordinate

their transmission capacity in order to specify a quality of service (QoS). QoS

control is one of ATM's most important features, allowing voice and video to be

25   transmitted smoothly. Differing levels of service include, for example,

Constant Bit Rate (CBR) that guarantees bandwidth for realtime voice and

video, Realtime variable Bit Rate (rt-VBR) that supports interactive

multimedia that requires minimal delays, and Available Bit Rate (ABR) that

adjusts bandwidth according to congestion levels for LAN traffic.

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5   The network 100 embodiment of the present invention implements an

enhanced crankback mechanism in order to provide a reliable, consistent QoS.

The network 100 embodiment extends the capabilities and functionality

specified in the PNNI routing protocols used between ATM switches in an ATM

network. PNNI is the basic routing standard through which ATM switches

10   inform each other about network topology so they can make appropriate

forwarding decisions. The PNNI specification defines the manner in which the

ATM switches reroute a connection to avoid any link or connection problems.

However, prior art PNNI implementations are inefficient in their ability to

reroute connections in the case of failures within a peer group. In contrast, the

15   enhanced crankback mechanism provided by embodiments of the present

invention eliminate this inefficiency, in part by making greater use of the ATM

switch topology within the various peer groups to overcome bad links or

connection failures.

20   Referring still to Figure 1, in a case where node 11 is a source, or

originating node, of group 10, and where node 21 is a destination, or destination

node, of group 20, the shortest path for reaching group 20 from group 10 is to

take the link 31 out of node 12 in group 10. In accordance with the prior art, if

link 41 in group 20 has a problem (e.g., such as a problem where it has run out

25   of resources or if the entry border node is transit restricted), the entry border

node 21 of group 20 would translate the crankback to the next higher level as

there is no path for it to reach the destination. This would be seen by the

source node 11 as the whole peer group 20 being blocked. Therefore it would

not even choose the link 32 through node 15 to node 22 even though there are

30   resources available in that path to reach the destination. Embodiments of the

5 present invention solve this problem by recognizing the alternate path of link
32.

The network 100 embodiment of Figure 1 uses a DTL (Designated
Transit List) to discover the originating peer group. The DTL is a data
10 structure that describes the path taken by a message as it transits a network.
The DTL informs the entry border node 21 which peer group is transmitting
this call. The entry border node 21 also has information of other border nodes
in its peer group that have connectivity to the peer group initiating this call.

15 In the present embodiment, if the entry border node 21 encounters a
failure to route a call to the destination node (e.g., node 25) and it discovers that
there are other nodes in the peer group having connectivity to the same
preceding peer group (e.g., group 10) through which the call has come, it can
generate the crankback as blocked at the succeeding end of a blocked
20 interface. This is another standard ATM Forum PNNI crankback type.

In the present embodiment, the blocked interface will be specified as the
border link (e.g., link 31) between the entry border node 21 and the preceding
peer group 10. If the preceding peer group 10 receives this crankback type as
25 the succeeding end of blocked interface, the peer group 10 will avoid that link
(e.g., link 31) and use another path to reach the destination, instead of treating
the whole peer group 20 as blocked.

For example, referring still to Figure 1, in a case where the entry border
30 node 21 has a failure to route the call to the destination node 25, the entry
border node 21 knows that there is connectivity to the preceding peer group 10

5   also through node 22. Therefore, in accordance with embodiments of the present invention, the entry border node 21 would return the crankback as a succeeding end of a blocked interface instead of returning a crankback specifying that the whole peer group 20 is blocked. The blocked interface would be specified as the interface between node 12 and node 21. The source node 12

10   would try the alternate route through node 15 and would reach the destination via link 32 instead of failing the connection permanently.

Thus, the network 100 embodiment in accordance with the present invention addresses the crankback problems when there are many border

15   nodes with connectivity to the preceding peer groups and the entry border node has only one link coming from the preceding peer group.

Referring to Figure 2, a diagram of a network 200 configuration in accordance with one embodiment of the present invention is shown. As shown

20   in Figure 2, the network 200 configuration includes the preceding peer group 10 and the succeeding peer group 20 as in Figure 1. However, the network 200 configuration shows a case where the same entry border node 21 has multiple links (e.g., link 29 and link 31) to the preceding peer group 10.

25   In the network 200 embodiment, the entry border node 21 has two links coming from peer group 10, one from node 12 and one from node 13. In this case, when the entry border node 21 returns the succeeding end of a blocked interface to the preceding peer group 10, node 11 would retry the connection through node 13 and will face the same failure from entry border node 21 (e.g.,

30   on link 41).

5   The network 200 embodiment of the present invention addresses this

problem by configuring the entry border node 21 to transport the node IDs of

the exit border nodes (e.g., nodes 12-13, and node 15) in the preceding peer

group 10 that have connectivity to this node. The border node 21 has this

information through the "hello" exchange over the outside links (e.g., links 31-

10   32 and link 29). PNNI signaling provides for the transport of application

specific information to be carried over the GAT (Generic application Transport)

Information Element (IE) in the RELEASE message.

The network 200 embodiment of the present invention uses the GAT IE

15   as a list to transport the exit border node IDs of the preceding peer group 10

that are connected to this blocked entry border node 21. This information is

transported using an organization specific application type in the GAT IE. In

one embodiment, the OUI is a Cisco OUI (Organization Unique Identifier). The

preceding peer group 10 can use this information to avoid the exact nodes

20   connected to the blocked node in the next peer group.

Thus, as shown in Figure 2, the entry border node 21 can specify that

the nodes connecting to it from the preceding peer group are node 12 and node

13. This information can be used by source node 11 to determine a better path

25   through node 15 and link 32.

Figure 3 shows a flowchart of a process 300 in accordance with one

embodiment of the present invention. As depicted in Figure 3, process 300

shows the steps of an enhanced crankback process as practiced by a network

30   (e.g., network 100) in accordance with one embodiment of the present

invention.

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Process 300 begins in step 301, where an exit border node (e.g., node 12) in a preceding peer group transmits a connection request to the entry border node (e.g., node 21) of the succeeding peer group. In step 302, if a call failure is detected, process 300 proceeds to step 303. If no call failure is detected,

10   process 300 proceeds directly to step 308 and completes the connection.

In step 303, in the case of a call failure, a determination is made as to whether multiple links exist to a common entry border node. As described above, in this case, the originating node needs information that will allow it to

15   recognize that more than one link leads to the blocked entry border node. If multiple links do not exist, in step 304, a crankback is transmitted from the succeeding peer group to the preceding peer group specifying a blocked interface. As described above, this blocked interface is described as being the link (e.g., link 31) between the exit border node of the preceding peer group and

20   the entry border node of the succeeding peer group. Process 300 then proceeds to step 306.

In step 303, if multiple links do exist, process 300 proceeds to step 305, where the blocked entry border node transmits a crank back (e.g., as described

25   above) and transmits a list specifying those nodes that have intergroup connectivity. As described above, the blocked entry border node transmits a list specifying node IDs of the exit border nodes (e.g., nodes 12-13, and node 15 of Figure 2) in the preceding peer group 10 that have connectivity to this node.

30   In step 306, the originating node (e.g., node 11) recognizes the blocked interface and utilizes alternate resources within its peer group having

5   connectivity with the succeeding peer group (e.g., node 15). Subsequently, in

step 307, a second connection request can be transmitted from the originating

node 11 that utilizes a different link (e.g., link 32) to the succeeding peer group.

In step 309, the connection is then completed.

10 <u>Computer system environment</u>

Referring to Figure 4, an ATM switch 400 is illustrated. As described in

the above discussions of the present invention, certain processes and steps are

discussed that are realized, in one embodiment, as a series of instructions (e.g.,

a software program, software code, etc.) that reside within a computer

15 readable memory 402 of an ATM switch 400 and are executed by one or more

processors 401 of the switch 400. When executed, the instructions cause

switch 400 to perform the specific functions and exhibit the specific behavior

which was described in detail above. A generalized example of such a switch

operable to implement the elements and functions of the present invention is

20 shown in Figure 4.

In general, the ATM switch 400 of the present invention includes one or

more central processor(s) 401 configured to access data and instructions from

a computer readable memory 402 (e.g., random access memory, static RAM,

25 dynamic RAM, etc.). The switch 400 also includes a switching matrix 405 for

implementing the packet switching for the packets received via a plurality of

ports 406.

The foregoing descriptions of specific embodiments of the present

30 invention have been presented for purposes of illustration and description.

They are not intended to be exhaustive or to limit the invention to the precise

5   forms disclosed, and obviously many modifications and variations are possible in light of the above teaching. The embodiments were chosen and described in order best to explain the principles of the invention and its practical application, thereby to enable others skilled in the art best to utilize the invention and various embodiments with various modifications as are suited to

10   the particular use contemplated. It is intended that the scope of the invention be defined by the Claims appended hereto and their equivalents.